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STOPPING WATER POLLUTION AT ITS SOURCE

MISA

Municipal/Industrial Strategy for Abatement

MONITORING COST ESTIMATES AND THEIR IMPLICATIONS FOR DIRECT DISCHARGERS IN THE ELECTRICAL GENERATION SECTOR

DECEMBER 1989

Environment Ontario

Jim Bradley
Minister

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MUNICIPAL-INDUSTRIAL STRATEGY FOR ABATEMENT
(MISA)

MONITORING COST ESTIMATES AND THEIR IMPLICATIONS FOR DIRECT DISCHARGERS IN THE ELECTRIC GENERATION SECTOR

Prepared by:
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DECEMBER 1989

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ABSTRACT

. Estimates of the incremental costs of monitoring to the electric power generation stations and associated facilities that are subject to the MISA Monitoring Regulation are derived and summarized.

. Twenty-seven power generating stations and associated facilities in Ontario, of which 24 are owned by Ontario Hydro and three by AECL, are subject to the MISA Monitoring Regulations.

. Capital and operating and maintenance (O & M) costs are estimated by generating station or facility for each of five key monitoring activities.

- sampling requirements (including costs associated with the transport of effluent samples from stations to labs)
- flow measurement
- chemical analyses
- toxicity testing
- reporting and supervision

. The point estimate of the total incremental capital costs for the sector is $6.1 million. Capital costs could range from $5.2 million to $7.0 million using a contingency factor of +/- 15%.

- Sampling equipment accounts for 51% of total capital costs, flow measurement installations account for 21%, analytical instrumentation accounts for 25% and reporting requirements account for the remaining 3%.

. Operating and maintenance costs over the 12-month period of the regulation are estimated to total $8.5 million, $\pm$ $1.2 million using a $\pm$ 15% uncertainty measure.

- Chemical analyses account for 61.2% of total O & M costs.

- Sampling, including transport of effluent samples to labs, accounts for 25.9% of total O & M costs.

- Of the remaining O & M costs, reporting and supervision costs account for 6.9%, toxicity testing for 5.6% and maintenance of flow meters for 0.2%.

- Monitoring activities by Ontario Hydro account for over 93% of the total estimated costs to the sector.

- Total incremental monitoring costs could range from $12.4 million to $16.8 million with a total point estimate for the sector of $14.6 million.

  - Estimates of total analytical and toxicity testing costs using Hydro in-house lab prices amount to $1.7 million less than estimates derived from commercial lab prices.

  - Using Hydro's in-house lab prices, total incremental costs could range from $10.0 million to $13.6 million.

- Based on financial impact tests and analyses, the incremental costs of monitoring are not expected to have adverse financial effects on Ontario Hydro or AECL.

1.0 BACKGROUND AND PURPOSE OF REPORT

1.1 MISA Objectives

The Municipal-Industrial Strategy for Abatement (MISA) intends to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways" (Ontario Ministry of the Environment 1986).

MISA consists of three broad components:

1. Development and promulgation of Regulations which specify (a) contaminant monitoring requirements, and (b) effluent limits.

2. Development of these effluent limits based on "best available technology economically achievable" (BATEA) or water quality impacts.

3. Implementation of abatement programs and enforcement activities.

Economic assessments are a fundamental component of the MISA program. The intent of the economic analyses is to determine the magnitude of the costs and benefits of various regulations and other program elements, reveal the distribution of these costs and benefits, evaluate the economic effects and implications of the potential costs and benefits and where possible, determine the least-cost mechanisms for achieving program objectives (Ontario Ministry of the Environment, 1987).

1.2 Sectors Affected by MISA

Regulations will be developed for all industrial establishments whether they discharge wastewaters directly into lakes and rivers or indirectly via municipal sewer systems. The first elements of the MISA program to be implemented are monitoring regulations on industrial establishments that discharge wastewaters directly into provincial waterways. Table 1.1 lists the industrial sectors for which monitoring regulations are being developed. Approximately 330 plants and mines in the province will be subject to monitoring regulations.

TABLE 1.1

INDUSTRIAL SECTORS SUBJECT TO MISA DIRECT DISCHARGE REGULATIONS

Industrial Sector[1]	SIC Nos.	Approximate Number of Plants in Ontario	Direct Discharger Plants or Sites under MISA Regulation
Metal Mining and Refining	0111-0619	N/A	68
Pulp, Paper and Paper Board	2711-2712	41	27
Iron and Steel	2911-2921	57	7
Metal Casting Foundries	2941-2999	300	13
Petroleum Refineries	3611	7	7
Chemical Manufacturing:	3711-3799	840	
Organic			19*
Inorganic			22*
Electric Power Generation	4911	89[1]	27[2]
Non-metallic and structural mineral quarries and plants (e.g., Cement, brick, lime, sand and gravel, dolomite)	062,081-2 351-2, 358-9	3,000**	125**

1 As defined for MISA program.

2 Ontario Ministry of the Environment. Development Document for the Draft Effluent Monitoring Regulation for the Electric Power Generation Sector, June 1989, page A-16.

* 4 plants in SIC 1800-1897 were included in the Organic Chemical Manufacturing Sector for purposes of the MISA Monitoring Regulation. Three plants in SIC 3399, 3571 and 3594 were included in the Inorganic Chemical Manufacturing Sector.

** Approximate number, subject to change

1.3 Effluent Monitoring Regulation for Ontario's Electric Power Generation Sector

The first phase of the MISA regulatory program is the promulgation of monitoring regulations for all plants or establishments within each industrial sector which discharge wastewaters directly into the natural environment. The proposed monitoring regulation for Ontario's electric power generation stations and associated facilities constitute the basis of this report.

Twenty-seven power generating stations and associated facilities in Ontario are subject to the monitoring regulations. These facilities include fossil- fuelled, nuclear and hydraulic power plants and are listed in Table 1.2. Ontario Hydro owns all of these plants except for three facilities which are owned and operated by Atomic Energy of Canada Limited (AECL).

The Electric Power Generation Monitoring Regulation lists 27 stations and associated facilities. For the purpose of this report, the Pickering nuclear station A and B are considered to be a single station since cost estimates from Ontario Hydro are based on one station. Similarly, Bruce Nuclear Power Development, Bruce Sewage Processing Plant, and Bruce Nuclear Waste Storage will all be included under Bruce Services since Hydro's cost estimates have been developed for a single facility. Therefore, cost estimates have been derived for 24 stations and associated facilities.

Monitoring requirements for the electric power generation stations are specified in two regulations:

1. "Effluent Monitoring - General" which specifies common sampling, analysis, toxicity testing, flow measurement, recording and reporting protocols and procedures for all MISA sectors; and

2. "Effluent Monitoring - Electric Power Generation Sector" which defines monitoring requirements specific to the electric power generation sector.

The monitoring requirements have been developed through negotiations at a Joint Technical Committee (JTC) consisting of representatives of Hydro, AECL, the Ministry and the federal government.

TABLE 1.2

STATIONS AND ASSOCIATED FACILITIES FOR
THE ELECTRIC POWER GENERATION SECTOR

Electric Power Generating Facility	Ownership	Location
Fossil Fuelled Thermal Generating Stations (TGS):		
1. Atikokan TGS	Ontario Hydro	Atikokan
2. J.C. Keith TGS*	Ontario Hydro	Windsor
3. Lakeview TGS	Ontario Hydro	Mississauga
4. Lambton TGS	Ontario Hydro	Courtright
5. Lennox TGS	Ontario Hydro	S. Fredericksberg
6. Nanticoke TGS	Ontario Hydro	Nanticoke
7. R.L. Hearn TGS*	Ontario Hydro	Toronto
8. Thunder Bay TGS	Ontario Hydro	Thunder Bay
Nuclear Powered Thermal Generating Stations (NGS) and Associated Facilities:		
9. Bruce A NGS	Ontario Hydro	Tiverton
10. Bruce B NGS	Ontario Hydro	Tiverton
11. Bruce Heavy Water Plants	Ontario Hydro	Tiverton
12. Bruce Nuclear Power Development and Services	Ontario Hydro	Tiverton
13. Bruce Sewage Processing Plant	Ontario Hydro	Tiverton
14. Bruce Nuclear Waste Storage Site	Ontario Hydro	Tiverton
15. Chalk River Nuclear Laboratories	Atomic Energy of Can.	Chalk River
16. Darlington NGS***	Ontario Hydro	Bowmanville
17. Darlington NGS (under construction)	Ontario Hydro	Bowmanville
18. Douglas Point Waste Management Facility**	Atomic Energy of Can.	Tiverton
19. Nuclear Power Demonstration Waste Management Facility**	Atomic Energy of Can.	Rolphton
20. Pickering A NGS	Ontario Hydro	Pickering
21. Pickering B NGS	Ontario Hydro	Pickering
Hydraulic Powered Generating Stations (GS):		
22. Sir Adam Beck 2 GS	Ontario Hydro	Niagara River
23. Pine Portage GS	Ontario Hydro	Nipigon River
24. DeCew NF 23 GS	Ontario Hydro	Welland Canal
25. Aguasabon GS	Ontario Hydro	Aguasabon River
26. Arnprior GS	Ontario Hydro	Madawaska River
27. Silver Falls GS	Ontario Hydro	Kaministikwia R.

* Mothballed
** Decommissioned
*** At least one unit operatinal during 1990

The "Effluent Monitoring - General" regulation came into force June 7, 1988 and will continue in force for each MISA sector indefinitely.

Monitoring under the Electric Power Generation Sector (EPGS) Regulation will come into force on the first day of the sixth month after it is promulgated and will continue in effect during the subsequent 12-month period. It will be terminated at the end of the 18-month (approximately) period at which time some monitoring activities will be continued as specified in the monitoring regulation. Some monitoring requirements will be specified in a subsequent "Effluent Limits Compliance Regulation" for this sector.

1.4 Purpose and Objectives of Present Report

Estimates of the potential incremental costs to each of the electric power generation stations and associated facilities in Ontario which are subject to the requirements of the sector monitoring regulation are presented. The economic effects and financial implications of these costs for Ontario Hydro and AECL will be analyzed. The focus of this analysis will be on the effects that these incremental costs might have on electricity rates.

A description of the electric power generation industry in Canada and Ontario, with relevant background data, are found report entitled: Economic and Financial Profile of the Ontario Electric Power Generation Industry (MOE, June 1989).

1.5 Cost Estimation Methodology and Information Sources

Incremental costs of monitoring consist of recurring operating and maintenance costs and one time capital and installation costs for equipment and instrumentations. In this report, capital and operating costs have been estimated for each monitoring function at each station and associated facility.

Steps involved in cost estimation include the determination of the activities and items which are required to implement each monitoring function specified in the regulation, subject to simplifying assumptions where necessary. This also involves estimating the number of person-days required to carry out different tasks.

Ontario Hydro staff contributed substantially to this analysis by providing detailed estimates of the Corporation's expected monitoring costs (May, 1989). These estimates and the explanations provided with them constitute the basis for the estimates presented in this report. Similarly, AECL has also supplied estimates with underlying rationale for their costs.

Single-valued or point estimates of costs based on specific assumptions and conditions are presented in this report. However, they should be treated with caution. Inputs required for different types of monitoring functions are often uncertain and there is some flexibility as to how individual stations may implement the various monitoring requirements. Estimates of capital costs are also subject to contingencies, error and uncertainty.

However, in a few instances, estimates presented here differ from those originally provided by Hydro and AECL. One reason for these differences was to make the estimates comparable with other industrial sectors. Commercial laboratory prices for chemical and bio-toxicity tests have been used rather than Hydro's unit test costs to develop analytical cost estimates.

Moreover, cost estimates are based on monitoring requirements specified at the date of this report. These specifications may be changed slightly when the Regulation is actually promulgated.

For the above reasons, ranges of capital and operating costs as well as point estimates are provided for some monitoring functions.

Cost estimates presented in this report were prepared during the first quarter of 1989.

Cost-effectiveness implications have been among the factors considered in arriving at the agreed-to protocols and requirements. Comments on the cost-effectiveness of the monitoring requirements and the proposed monitoring facilities to be installed will be presented in later sections.

2.0 MONITORING COST ESTIMATES

2.1 Regulation Requirements

The ("General" and "Electric Power Generation") Effluent Monitoring Regulations specify requirements for five major monitoring activities which each wastewater discharger must implement to various degrees and levels of effort:

1. sampling requirements;
2. flow measurement;
3. analytical requirements (characterization and routine analyses);
4. toxicity testing; and
5. reporting.

In addition, the General Regulation specifies sampling, analytical and reporting protocols which must be followed by all industrial sectors.

Thirteen types of effluent streams or "sampling points" are defined in the specific Regulation for the electric power generation facilities. These are:

Process;	Once-through cooling water;
Batch Discharge;	Equipment cleaning;
Boiler Blowdown;	Contaminated building;
Combined;	Waste disposal site;
Event Discharge;	Coal Pile; and
Emergency overflow;	Once-through Cooling
Stormwater;	Water Temperature.

The MISA monitoring requirements for the electric power generation sector provide for different testing schedules according to the type of effluent stream and the type of station or facility which is generating the effluent. However, process effluent streams at different stations and associated facilities that utilize identical electric power generation systems processes (e.g. nuclear and fossil-fuelled) must test for the same compounds and at the same frequency.

Table 2.1 shows a summary of the type and number of effluent streams by station or facility category for Ontario Hydro and AECL. For Hydro, nuclear stations have the most sampling points with 102, followed by fossil-fuelled with 91 and hydraulic with 28. The total number of sampling points for Ontario Hydro is 221. On the other hand, AECL facilities, have only 18 sampling points.

TABLE 2.1

SUMMARY OF NUMBER AND TYPE OF EFFLUENT STREAM
BY STATION OR FACILITY CATEGORY

CATEGORY	STATN\FACIL	EFFLUENT STREAMS OR SAMPLING POINTS: PROCESS*	EMERGENCY OVERFLOW**	ONCE THRU COOLING***	POTENTIAL. CONTAM BLDG	STORM WATER	EQUIPMENT CLEANING	WASTE DISPOSAL	TOTAL
ONTARIO HYDRO									
FOSSIL-FUELLED:	ATIKOKAN	5	1	1	1	1			9
	THUNDER BAY	4	1	1	3	4			13
	LAKEVIEW	7	2	1	9	2	1		22
	LAMBTON	4	1	3	3		1		12
	NANTICOKE	5		1	9	2	1		18
	LENNOX	3		3	4		1		11
	KEITH					2			2
	HEARN			1	2	1			4
	SUBTOTAL:	28	5	11	31	12	4		91
NUCLEAR:	DARLINTON CN	3				6	3		12
	DARLINGTON	4		1	7	2			14
	BRUCE A	4		1	4	2			11
	BRUCE B	4		1	8	3			16
	BRUCE HWP	2		1		3	1		7
	BRUCE SERV	6				6	1		13
	PICKERING A&B	5		13	8	3			29
	SUBTOTAL:	28	0	17	27	25	5		102
HYDRAULIC:	AGUASABON				1	1			2
	ARNPRIOR				3	1			4
	S A BECK II			2	8	2			12
	DECEW II			2	1	2			5
	PINE PORTAGE				2	1			3
	SILVER FALLS				1	1			2
	SUBTOTAL:	0	0	4	16	8			28
	HYDRO TOTAL:	56	5	32	74	45	9	0	221
AECL									
NUCLEAR:	NDP WMF				1		1		2
	DOUGLAS PT				2		2		4
	CHALK RIVER	3	1	1		4	0	3	12
	AECL TOTAL:	3	1	1	3	4	3	3	18
	SECTOR TOTAL	59	6	33	77	49	12	3	239

* Includes process, batch discharge, boiler blowdown, combined and event discharge effluent streams.

** Includes coal pile effluent streams.

*** Includes once-through cooling water temperature effluent streams.

SOURCE: MOE, WATER RESOURCES BRANCH, 1989; EPG SECTOR MONITORING REGULATION, 1989.

In the sections to follow, specific requirements for each monitoring activity are described and the estimated costs are derived. Details about each type of requirement may be found in the Regulation and the relevant Development Document (Ontario Ministry of the Environment, June 1989). For Ontario Hydro the costs have been disaggregated by fossil-fuelled, nuclear and hydraulic generation sources. As noted, these estimated costs will for the most part be incurred only for the 12-month period of the regulation.

2.2 Sampling

Sampling protocols and specifications are defined in Section 3 of the "Effluent Monitoring - General" Regulation.

This function involves taking water samples from designated sampling points at each effluent stream under prescribed procedures and conditions, storing samples under refrigeration where necessary and transporting samples to lab facilities within a prescribed time period. Samples must be taken to perform characterization and routine analyses and biological toxicity tests. Samples may be taken by hand under the prescribed frequency or by means of automatic sampling equipment. By whatever means they are collected, samples must then be taken to a facility for preparation and, if necessary, under refrigerated storage.

Larger amounts of water must be taken for toxicity tests than for chemical tests, although the procedures are similar.

Capital costs will be incurred for refrigeration equipment and automatic samplers where required. In addition to the purchase price of automatic samplers, installation costs must be incurred.

Operating costs for sampling involve labour to collect and prepare samples and equipment maintenance. Transportation of samples from sampling points to sample preparation and storage locations also involve costs.

Ontario Hydro has stated that most chemical tests will be conducted at their own in-house laboratory in Toronto for stations located in Southern Ontario. Samples from the two fossil-fuel and three hydraulic stations in Northwestern Ontario will be shipped to a commercial laboratory located in Thunder Bay.

According to Ontario Hydro maintenance costs of sampling devices are assumed to be one half of the equipment cost. However, in cases where flow-meters and samplers are subject to "ice-jams", plugging or fouling, maintenance costs could be much higher. Maintenance costs would also include the "de-bugging" and calibration of devices.

Although maintenance costs are significant over the life of the equipment, the total maintenance costs may not be "incremental", except for overtime payments, because Hydro maintenance technicians are already in place at stations and associated facilities. Therefore, maintenace costs may be overstated for the 12-month monitoring period.

Incremental personnel requirements and costs have been estimated for the purpose of obtaining, preserving and preparing the samples and the reading and recording of data.

Fossil-fuelled and nuclear stations will each be hiring one additional technician as a result of the MISA monitoring regulation which would amount to about 11 additional staff positions. Hydro has estimated that 90 hours per week per station are required to complete the required sampling job tasks. On the other hand, hydraulic stations which have no on-site personnel will require only 7 person-days per month to complete all required monitoring tasks. The wage rates reported by Hydro range from $20.50 per hour for a data clerk to $57.42 per hour for a senior supervisor. These wage rates were used to generate the operation and maintenance costs summarized in Table 2.2.

Capital expenditures for sampling may include equipment, engineering and installation costs. Equipment cost prices were estimated by Hydro's Generation Engineering Management Section and have not been verified with individual stations or facilities.

After collection and preparation, samples will then have to be stored at a temperature no higher than 10°C, as well as be prevented from freezing. Each station and associated facility may require refrigeration equipment to store samples. Hydro assumed a price of $5,000 for each refrigerator to store samples.

Automatic composite sampler installations must house a refrigerated sample holder in an insulated housing to protect from freezing. Some suppliers

as well as Hydro have stated that automatic flow-proportional samplers, including refrigeration equipment, cost between $7,000 and $10,000. Automatic ice-cooled portable samplers will also be used by Hydro at certain locations. This equipment costs about $6,000 per unit. Installation costs, which include temperature recorders, electrical supply, signal cables and construction, are sensitive to site-specific circumstances and can be as much as two times the equipment cost.

Table 2.2 summarizes the total number of automatic sampling devices to be installed at each station or facility as well as the associated capital and operating costs. Capital expenses include equipment, installation, and building costs. Operating expenses include staff time required for sample collection and preparation, instrumentation reading and equipment maintenance. Total equipment maintenance costs make up less than 3% of the total operating costs for sampling.

As shown in Table 2.2, total estimated sampling costs for the sector as a whole, as provided by Ontario Hydro and AECL representatives, are about $5.1 million for the one year monitoring period. Hydro intends to install a total of 76 sampling devices at a capital cost of about $2.8 million and operating cost of $1.8 million. AECL will incur total capital and operating costs for sampling of $421,000 or about 8% of the total cost for sampling in the sector.

Disaggregations of Hydro's total sampling costs by station and associated facilities are shown in Figure 2.1 Graph 2.1a shows nuclear and fossil-fuelled stations incurring almost 90% of Hydro's total sampling cost of $4.6 million. Graphs 2.1b, c and d display the capital and operating costs by individual stations for each type of electric power source. The Bruce Services facility, under nuclear, which includes Nuclear Power Development and Services facility, the Sewage Processing Plant, and Nuclear Waste Storage Site facility, has the highest total cost of sampling.

TABLE 2.2

SAMPLING DEVICES REQUIRED AND CAPITAL AND OPERATING COSTS

STATION CATEGORY	STATION\FACILITY	NO. OF STREAMS	NO. OF SAMPLING DEVICES	CAPITAL ($)	OPERATING ($)	TOTAL ($)
ONTARIO HYDRO						
FOSSIL-FUELLED:	ATIKOKAN	9	6	139,000	138,140	277,140
	THUNDER BAY	13	7	163,000	120,260	283,260
	LAKEVIEW	22	7	209,250	190,420	399,670
	LAMBTON	12	4	169,200	118,400	287,600
	NANTICOKE	18	7	246,050	144,370	390,420
	LENNOX	11	4	156,050	96,380	252,430
	KEITH	2	1	50,000	16,840	66,840
	HEARN	4	2	87,000	14,700	101,700
	SUBTOTAL:	91	38	1,219,550	839,510	2,059,060
NUCLEAR:	DARLINTON CONST.	12	4	185,000	99,130	284,130
	DARLINGTON	14	3	112,000	120,200	232,200
	BRUCE A	11	3	102,000	117,860	219,860
	BRUCE B	16	3	102,000	121,000	223,000
	BRUCE HWP	7	2	132,000	72,600	204,600
	BRUCE SERVICES	13	5	375,000	162,740	537,740
	PICKERING A & B	29	6	186,000	153,740	339,740
	SUBTOTAL:	102	26	1,194,000	847,270	2,041,270
HYDRAULIC:	AGUASABON	2	2	67,000	21,150	88,150
	ARNPRIOR	4	2	67,000	21,150	88,150
	S A BECK II	12	2	67,000	21,850	88,850
	DECEW II	5	2	67,000	21,850	88,850
	PINE PORTAGE	3	2	67,000	21,150	88,150
	SILVER FALLS	2	2	67,000	21,150	88,150
	SUBTOTAL:	28	12	402,000	128,300	530,300
	HYDRO TOTAL:	221	76	2,815,550	1,815,080	4,630,630
AECL						
NUCLEAR:	DOUGLAS POINT	4	0	0	35,000	35,000
	NPD WMF	2	0	0	20,000	20,000
	CHALK RIVER LABS	12	8	250,000	116,000	366,000
		18	8	250,000	171,000	421,000
	SECTOR TOTAL:	239	84	3,065,550	1,986,080	5,051,630

NOTE: CAPITAL COSTS INCLUDE EQUIPMENT, INSTALLATION, AND BUILDING COSTS.
OPERATING COSTS INCLUDE EQUIPMENT MAINTENANCE AND PERSONNEL COSTS.

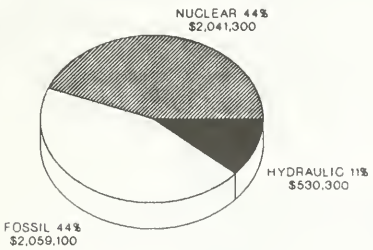
SOURCE: J. REEVES, ONTARIO HYDRO, MAY 1989
J. VAN BERLO, AECL, MAY 1989

Figure 2.1

2.1a

SAMPLING
CAPITAL & OPERATING COSTS
ONTARIO HYDRO

BY ELECTRIC POWER SOURCE

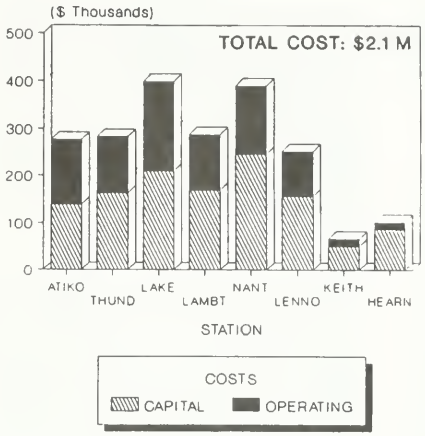


TOTAL COST: $4.6 MILLION

SOURCE: ONTARIO HYDRO COST ESTIMATES, MAY 1989

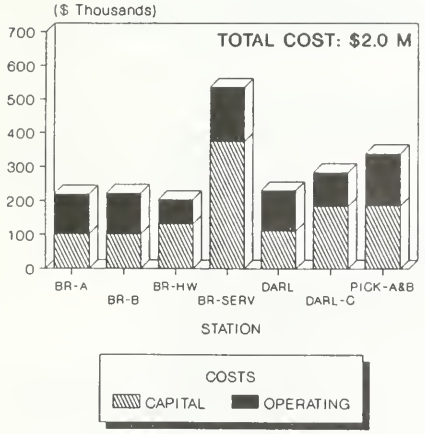
2.1b

SAMPLING
FOSSIL-FUELLED STATIONS
ONTARIO HYDRO



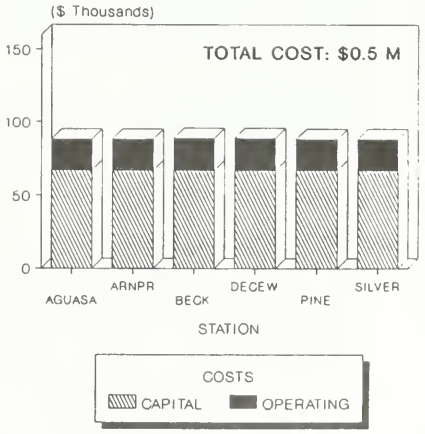
2.1c

SAMPLING
NUCLEAR STATIONS
ONTARIO HYDRO



2.1d

SAMPLING
HYDRAULIC STATIONS
ONTARIO HYDRO



The average point estimate of total sampling costs for the sector is approximately $194,000. Total average sampling costs range from as low as $20,000 to as high as $537,700 per year per station. The wide range reflects the differing number and types of sampling points for each station or facility.

The transportation of lab samples from the stations located in Northwestern Ontario will be carried out by Ontario Hydro technicians, who presently travel to these stations regularly to service and maintain equipment. According to Hydro, technicians will use present company vehicles but distances travelled in excess of their normal activities will be charged at a rate of $0.29 km. No extra capital costs for transportation will be incurred by Hydro.

For the remaining Hydro fossil-fuelled and nuclear stations and facilities, samples are assumed to transported by an Econo-Line truck equipped with refrigeration equipment. The truck would be contracted for the 12 month monitoring period. The cost of operating the truck has been estimates by Ontario Hydro to total $1,000 per station or facility per month.

When Hydro technicians use company vehicles, the costs are derived by multiplying the round trip distance between each station or facility and the laboratory in Toronto or Thunder Bay and by the number of trips to the lab and then multiplying by the Hydro mileage rate of $0.29 per km. Total expected transport costs for Hydro total about $183,700. Table 2.3 summarizes the transportation costs to laboratories.

Presumably, the charges Hydro is claiming for transportation to the labs in Thunder Bay or Toronto are in excess of what the distances the technicians would otherwise travel in the course of their duties.

AECL states that all of their samples will be analyzed by commercial labs. Samples will be transported from each facility to the lab by a courier service. As shown in Table 2.3 transportation costs for AECL are estimated to total $8,000 for the 12-month monitoring period.

TABLE 2.3

SUMMARY OF TRANSPORTATION COSTS

STATION CATEGORY	STATION\FACILITY	ROUND TRIP DISTANCE TO LAB IN KM: TORONTO	ROUND TRIP DISTANCE TO LAB IN KM: THUNDER BAY	NO. OF TRIPS PER YEAR	ANNUAL VEHICLE COS ($0.29\KM) ($)
ONTARIO HYDRO					
FOSSIL-FUELLED:	ATIKOKAN		600	52	9,048
	THUNDER BAY		100	52	1,508
	LAKEVIEW *				12,000
	LAMBTON *				12,000
	NANTICOKE *				12,000
	LENNOX *				12,000
	KEITH	350		12	1,218
	HEARN	100		12	348
	SUBTOTAL:				60,122
NUCLEAR:	DARLINTON CONST.*				12,000
	DARLINGTON *				12,000
	BRUCE A *				12,000
	BRUCE B *				12,000
	BRUCE HWP *				12,000
	BRUCE SERVICES *				12,000
	PICKERING A & B *				12,000
	SUBTOTAL:				84,000
HYDRAULIC:	AGUASABON		800	36	10,868
	ARNPRIOR	400		36	4,176
	S A BECK II	400		72	8,352
	DECEW II	200		48	2,784
	PINE PORTAGE		600	36	8,780
	SILVER FALLS		200	36	4,604
					39,564
	HYDRO TOTAL COST:				183,686
AECL:					
NUCLEAR:	DOUGLAS POINT **				1,000
	NPD WMF **				1,000
	CHALK RIVER **				6,000
	AECL TOTAL COST:				8,000
	SECTOR TOTAL:				191,686

* HYDRO HAS ASSUMED TRANSPORTATION COST AT $1000 PER STATION OR FACILITY PER MONTH.

** AECL HAS ASSUMED ABOUT $83 PER MONTH FOR DOUGLAS POINT AND NPD FACILITIES AND $500 PER MONTH FOR CHALK RIVER.

SOURCE: J. REEVES, ONTARIO HYDRO, MAY 1989.
J. VAN BERLO, AECL, MAY 1989.

2.3 Flow Measurement

Flow measurements are required to calculate total loadings of contaminants discharged to the environment. This is accomplished by multiplying flow rates by concentrations of each pollutant derived from chemical analyses.

Flow measurement accuracy requirements at each type of sampling point are summarized in Table 2.4.

The number of sampling devices and estimated capital and operating costs by station and associated facility are summarized in Table 2.5 for the sector. All Hydro stations and facilities and the Chalk River facility of AECL are required to install flow measurement devices which comply with the accuracy requirements in Table 2.4. The average point estimate of total capital and operating cost for flow measurement devices at each station is about $58,000.

Capital costs of flow measurement devices, which include equipment and installation and building costs, were supplied by Hydro and AECL representatives. According to Hydro's engineering department, the price of a flow meter is $8,000 per unit, a flow recorder is $2,000 and a pump running time meter is $500. Installation costs have been estimated by Hydro to be two times the price of equipment. Actual installation costs will vary among stations due to site-specific characteristics such as the volume of effluent flow, location of pipes, etc.

Estimated capital expenditures for flow measurement range from $0 to $159,000 per site as shown in Table 2.5. Total capital expenses for Hydro amount to about $1.4 million; for the sector $1.5 million.

Estimated operating costs of flow measurement which is the cost of equipment maintenance, as provided by Hydro and AECL, range from $0 to $22,100 per location totalling about $180,000 for the sector.

In Figure 2.2 the percentage breakdown of Hydro's total capital and operating cost estimates among electric power source categories are displayed in Graph 2.2a of Figure 2.2. Fossil-fuelled stations will incur about 41% of the total cost of flow measurement. Graphs 2.2b, c and d display capital and operating costs for each station and associated facility by electric power source.

TABLE 2.4

REQUIREMENTS FOR FLOW MEASUREMENT UNDER THE ELECTRIC POWER GENERATION SECTOR MONITORING REGULATION

Outfall Type	Flow Measurement Requirements	Accuracy
Process Effluent	Measured, estimated or calculated	+/- 5% of actual flow using a primary device, +/- 2% of full scale flow using a secondary device
Emergency Overflow	Event duration and approximate volume of discharge	+/- 20% of actual flow
Cooling Water Effluent	Measured or estimated flow at time of sampling	+/- 20% of actual flow
Stormwater	Measured or estimated at time of storm event	+/- 20% of actual flow
Equipment Cleaning	Measured or estimated flow at time of sampling	+/- 20% of actual flow
Contaminated Building	Measured or estimated flow at time of sampling	+/- 20% of actual flow
Waste Disposal Site Effluent	Volume and duration of each discharge event	+/- 20% of actual flow

NOTE: If existing devices can be proven to have a +/- 15% accuracy, they will be accepted for use in flow measurement.

SOURCE: Ontario Ministry of the Environment. Development Document for the Draft Effluent Monitoring Regulation for the Electric Power Generation Sector, June 1989.

TABLE 2.5

FLOW MEASUREMENT DEVICES REQUIRED AND CAPITAL AND OPERATING COSTS

STATION CATEGORY	STATION\FACILITY	NO. OF STREAMS	NO. OF FLOW MEASURE. DEVICES	CAPITAL ($)	OPERATING ($)	TOTAL ($)
ONTARIO HYDRO						
FOSSIL-FUELLED:	ATIKOKAN	9	2	33,000	4,700	37,700
	THUNDER BAY	13	8	42,000	6,200	48,200
	LAKEVIEW	22	10	159,000	22,100	181,100
	LAMBTON	12	5	72,000	9,800	81,800
	NANTICOKE	18	7	126,000	17,500	143,500
	LENNOX	11	6	39,000	5,700	44,700
	KEITH	2	5	9,000	1,600	10,600
	HEARN	4	7	12,000	2,100	14,100
	SUBTOTAL:	91	50	492,000	69,700	561,700
NUCLEAR:	DARLINTON CONST.	12	3	96,000	12,800	108,800
	DARLINGTON	14	11	45,000	6,700	51,700
	BRUCE A	11	12	48,000	7,200	55,200
	BRUCE B	16	20	60,000	9,200	69,200
	BRUCE HWP	7	3	27,000	4,200	31,200
	BRUCE SERVICES	13	15	135,000	20,100	155,100
	PICKERING A & B	29	21	60,000	9,200	69,200
	SUBTOTAL:	102	85	471,000	69,400	540,400
HYDRAULIC:	AGUASABON	2	4	36,000	5,200	41,200
	ARNPRIOR	4	8	42,000	6,200	48,200
	S A BECK II	12	18	57,000	8,700	65,700
	DECEW II	5	4	36,000	5,200	41,200
	PINE PORTAGE	3	6	39,000	5,700	44,700
	SILVER FALLS	2	4	36,000	5,200	41,200
	SUBTOTAL:	28	44	246,000	36,200	282,200
	HYDRO TOTAL:	221	179	1,209,000	175,300	1,384,300
AECL						
NUCLEAR:	DOUGLAS POINT	4	0	0	0	0
	NPD WMF	2	0	0	0	0
	CHALK RIVER LABS	12	6	120,000	4,600	124,600
	AECL TOTAL:	18	6	120,000	4,600	124,600
	SECTOR TOTAL:	239	185	1,329,000	179,900	1,508,900

NOTE: CAPITAL COSTS INCLUDE EQUIPMENT AND INSTALLATION COSTS.
OPERATING COSTS INCLUDE EQUIPMENT MAINTENANCE AND PERSONNEL COSTS.

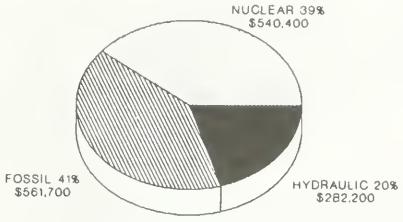
SOURCE: J. REEVES, ONTARIO HYDRO, MAY 1989.
J. VAN BERLO, AECL, MAY 1989.

Figure 2.2

2.2a

FLOW MEASUREMENT
CAPITAL & OPERATING COST
ONTARIO HYDRO

BY ELECTRIC POWER SOURCE

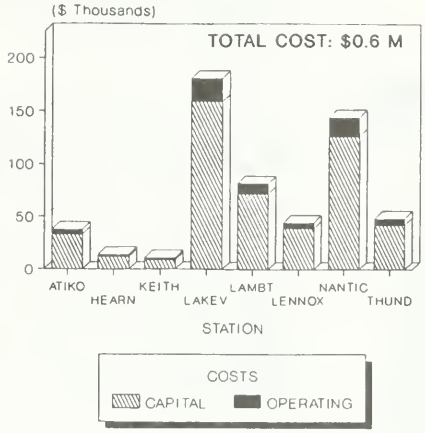


TOTAL COST: $1.4 MILLION

SOURCE: ONTARIO HYDRO COST ESTIMATES, MAY 1989

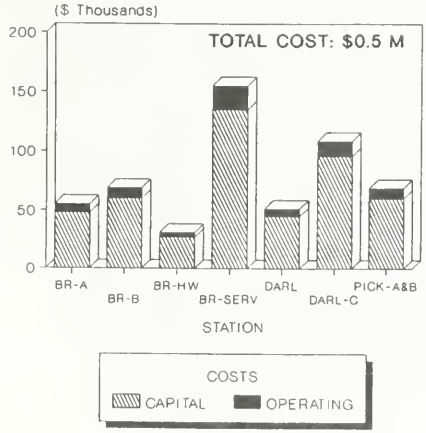
2.2b

FLOW MEASUREMENT
FOSSIL-FUELLED STATIONS
ONTARIO HYDRO



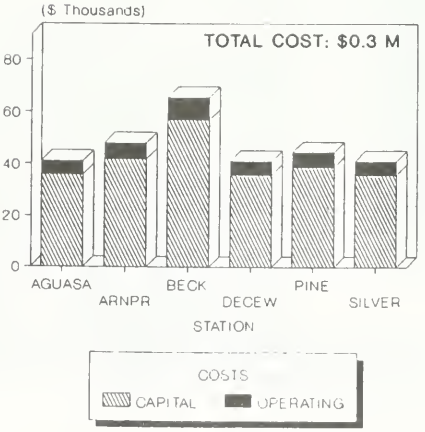
2.2c

FLOW MEASUREMENT
NUCLEAR STATIONS
ONTARIO HYDRO



2.2d

FLOW MEASUREMENT
HYDRAULIC STATIONS
ONTARIO HYDRO



2.4 Analytical Costs

Each station and associated facilities will be required to conduct three types of analyses on effluent streams including characterization, routine chemical testing of effluent samples and bio-toxicity tests.

In other industrial sectors, it was assumed that all samples would be sent to commercial laboratories for analyses in order to generate analytical cost estimates that were comparable from one plant to another (e.g. Pulp and Paper Sector, 1989). As noted earlier, analytical costs will be estimated in the same way for this section although, Ontario Hydro operates its own laboratory facilities and has stated that it will carry out its own routine and characterization tests. AECL has indicated that its analytical testing will be contracted to commercial labs which is consistent with the estimation procedure followed in this study.

The costs of chemical analysis for the 12-month period are based on the average commercial laboratory test prices that were derived from a survey of labs in Ontario, Quebec and the U.S. by M.M. Dillon Ltd. (July 1988). These prices are summarized in Table 2.6 and are based only on Ontario laboratories. The 27 test groups listed contain about 150 individual chemicals.

Prices of laboratory tests include quality assurance/quality control (QA/QC) samples and the preparation of required reports.

The listed prices may be slightly overstated because volume discounts are likely to apply, given the extent of MISA testing. In addition, the price of testing a single chemical which is part of a larger Analytical Test Group may be less than is indicated as the price for the entire group so that the actual cost of an analysis may be lower. On the other hand, lab prices represented in Table 2.6 were collected in 1987 and may have increased since then for some test groups.

TABLE 2.6

AVERAGE ONTARIO COMMERCIAL LABORATORY PRICES
FOR ANALYTICAL TEST GROUPS

	ANALYTICAL TEST GROUP	AVERAGE PRICE ($)
1.	Chemical Oxygen Demand (COD)	29.78
2.	Cyanide	36.10
3.	Hydrogen Ion (pH)	6.84
4.	Nitrogen	86.99
5.	Organic Carbon (DOC)	57.03
6.	Total Phosphorus	25.12
7.	Specific Conductance	9.44
8.	Suspended Solids (TSS/VSS)	14.87
9.	Total Metals	84.10
10.	Hydrides	23.33
11.	Chromium (Hexavalent)	20.47
12.	Mercury	25.77
13.	Total Alkyl Lead	172.00
14.	Phenolics (4AAP)	42.93
15.	Sulphide	29.80
16.	Volatiles, Halogenated	239.90
17.	Volatiles, Non-Halogenated	176.81
18.	Volatiles, Water Soluble	126.50
19.	Extractables, Base Neutral	427.49
20.	Extractables, Acid (Phenolics)	245.68
21.	Extractables, Phenoxy Acid Herbicides	188.09
22.	Extractables, Organochlorine Pesticides	270.14
23.	Extractables, Neutral-chlorinated	232.04
24.	Chlorinated Dibenzo-p-dioxins and Dibenzofurans	1,228.27
25.	Solvent Extractables (oil and grease)	36.00
26.	Fatty and Resin Acids	133.18
27.	PCBs (Total)	103.90
28.	Gas Chromatography and Mass Spectrometry Open Scans	850.00
E1	Iron	24.00

Source: Derived from data in M.M. Dillon, July 1988 and subsequent telephone survey results reported by MOE Laboratory Services Branch staff.

Routine and characterization testing represents the largest component of the incremental operating costs associated with monitoring, amounting to $5.2 million or 60% of the total operating cost of monitoring for the sector. Total analytical costs are summarized in Table 2.7 for both Ontario Hydro and AECL. Ontario Hydro claims that it will incur about $1.5 million in additional capital costs for instrumentation required for continuous analytical testing equipment. The costs include the purchase of on-line pH analyzers and conductivity meters as well as recorders for each instrument. Because the operating cost estimates shown in Table 2.7 include pH and conductivity tests, analytical operating costs for Hydro are over-estimated by approximately 14%.

2.4a Characterization Analyses

Characterizaton is a procedure which identifies, quantitatively, the presence or absence of all the chemicals on the Effluent Monitoring Priority Pollutants List (EMMPL) using analytical techniques specified in the General Effluent Monitoring Regulation.

All generating stations and associated facilities in the EPG Sector having process effluents, boiler blowdown effluents, and batch discharge effluent streams are required to perform quarterly characterization analyses on each of these streams.

In cases where characterization tests of effluent streams are required on an "event" basis, it was assumed that this would occur at least once per month or 12 times per year. Cost estimates were developed under this frequency assumption for all effluent streams requiring "event" characterization.

Table 2.7 summarizes estimates of characterization analyses costs, excluding transportation, per station. Total annual characterization costs amount to $983,800 for the sector. The annual characterization costs range from $0 to $128,000 per station. Total characterization costs for Hydro amount to $936,500.

Characterization costs reported by Ontario Hydro using their own in-house lab prices amount to $673,600 or $262,900 less when compared to costs estimates using commercial lab prices.

TABLE 2.7

SUMMARY OF ANALYTICAL COSTS

STATION CATEGORY	STATION\FACILITY	# OF STREAMS	CAPITAL ($)	OPERATING ROUTINE ($)	OPERATING CHARACTER ($)	TOTAL ($)
ONTARIO HYDRO						
FOSSIL-FUELLED:	ATIKOKAN	9	93,800	249,700	79,400	422,900
	THUNDER BAY	13	93,800	317,300	63,500	474,600
	LAKEVIEW	22	109,900	410,700	111,000	631,600
	LAMBTON	12	93,800	284,300	79,700	457,800
	NANTICOKE	18	93,800	404,300	79,600	577,700
	LENNOX	11	77,800	198,600	47,600	324,000
	KEITH	2	0	53,800	0	53,800
	HEARN	4	8,200	47,800	0	56,000
	SUBTOTAL:	91	571,100	1,966,500	460,800	2,998,400
NUCLEAR:	DARLINTON CONST.	12	109,406	236,500	45,500	391,406
	DARLINGTON	14	66,353	229,200	56,300	351,853
	BRUCE A	11	94,471	213,200	56,300	363,971
	BRUCE B	16	96,353	233,800	56,300	386,453
	BRUCE HWP	7	53,735	49,600	28,700	132,035
	BRUCE SERVICES	13	227,794	457,800	128,000	813,594
	PICKERING A & B	29	116,088	358,300	104,600	578,988
	SUBTOTAL:	102	764,200	1,778,400	475,700	3,018,300
HYDRAULIC:	AGUASABON	2	29,200	12,200	0	41,400
	ARNPRIOR	4	29,200	18,800	0	48,000
	S A BECK II	12	29,200	46,200	0	75,400
	DECEW II	5	29,200	23,000	0	52,200
	PINE PORTAGE	3	29,200	15,500	0	44,700
	SILVER FALLS	2	29,200	12,200	0	41,400
	SUBTOTAL:	28	175,200	127,900	0	303,100
	HYDRO TOTAL:	221	1,510,500	3,872,800	936,500	6,319,800
AECL						
NUCLEAR:	NDP WMF	2	0	22,400	0	22,400
	DOUGLAS POINT	4	0	21,500	0	21,500
	CHALK RIVER LABS	12	0	249,300	47,300	296,600
	AECL TOTAL:	18	0	293,200	47,300	340,500
	SECTOR TOTAL:	239	1,510,500	4,166,000	983,800	6,660,300

SOURCE: MOE WATER RESOURCES BRANCH, EPG SECTOR
MONITORING REGULATION, JUNE 1989.

2.4b Routine Analyses

Routine analyses involve testing of samples taken at four frequency levels - daily, three times per week, weekly and monthly depending on the effluent stream. In addition, sampling points such as emergency overflow are to be monitored on an event basis. Tests for a limited number of contaminants are to be made on process effluents daily, 3x weekly, weekly and monthly. Additional analyses at different frequencies are required for each type of electric power generation category. Consequently, the costs of routine analyses will vary among stations.

The costs of routine analyses at each station are estimated in the following manner.

(a) In Part C, Schedule A to J of the Regulation, the frequency of each test required for all stations is specified.

(b) The total number of each type of test for each type of station over the 12-month period of the regulation is calculated. The total volume or number of sample containers that will be generated and must be transported to labs is also estimated.

(c) At each facility the number of each type of test to be carried out over the 12-month period is multiplied by the price of that test to determine the analytical cost for the particular test group over the period of the Regulation.

(d) Add together all 12-month test costs to determine total routine analyses costs for each station.

Table 2.7 shows the total costs for routine analyses which amount to about $4.2 million for the sector. These costs are based on the commercial lab prices shown in Table 2.6. The average point estimate for routine costs (excluding characterization costs) amounts to $161,500 per year per station. These costs exclude transportation to labs which have been estimated in Section 2.2.

The total routine analyses cost for Ontario Hydro amounts to about $3.9 million. Using Hydro's lab charges, the total operating cost for routine testing amounts to $3.6 million.

2.5 Toxicity Testing

Biological toxicity testing involves the use of a static 96-hour rainbow trout mortality test and a 48-hour Daphnia magna (a small invertebrate crustacean) mortality test.

Process and boiler blowdown effluent discharges which are final discharge points are to be tested monthly. However, if three consecutive monthly tests result in no more than two dead trout out of every 10, water samples need only be collected and tested quarterly thereafter. This provision does not apply to the Daphnia magna test which must be carried out monthly in any event. Quarterly toxicity testing is required for all once-through cooling water discharge points.

Table 2.8 shows the maximum and minimum number of biotoxicity tests that could be required annually at each station. At least six trout tests, and at most twelve, must be carried out during the year for each test stream of every station indicated except for once-through cooling water streams where only four tests are required. Twelve daphnia tests must be carried out for each test stream except for once-through cooling water streams where testing is quarterly.

Toxicity testing costs are based on the following commercial lab prices for a full dilution series:

Trout:	$360 per test
Daphnia:	$240 per test
	$600 per test

Collection and transport costs for toxicity tests were discussed in the previous sections.

Using these prices and the maximum testing schedule of one of each test per month on each eligible outlet, the maximum total cost of this function during the 12-month period amounts to $472,800 for the sector as shown in Table 2.8. If the minimum number of fish toxicity tests were carried out for all stations and facilities in the sector, the total annual cost for both types of toxicity tests would be $351,800 a difference of $121,000.

TABLE 2.8

ANNUAL OPERATING COST OF TOXICITY TESTING

STATION\FACILITY	NUMBER OF TEST STREAMS PROC*	CW*	ANNUAL POTENTIAL NUMBER OF TROUT/DAPHNIA TESTS MIN.	MAX.	MIN. COST** ($)	MAX. COST*** ($)
ONTARIO HYDRO						
BRUCE NUCLEAR DEVELOPMENT SERVICES & WASTE STORAGE SITE	2	0	12 / 24	24 / 24	10,080	14,400
BRUCE HEAVY WATER PLANT	2	1	16 / 28	28 / 28	12,480	16,800
BRUCE SEWAGE PROCESSING PLANT	1	0	6 / 12	12 / 12	5,040	7,200
BRUCE A NGS	4	1	28 / 52	52 / 52	22,560	31,200
BRUCE B NGS	4	1	28 / 52	52 / 52	22,560	31,200
DARLINGTON NGS	4	1	28 / 52	52 / 52	22,560	31,200
DARLINGTON NGS (UNDER CONSTRUCTION)	3	0	18 / 36	36 / 36	15,120	21,600
PICKERING NGS	5	13	82 /112	112 /112	56,400	67,200
SUBTOTAL FOR NUCLEAR:					166,800	220,800
ATIKOKAN TGS	5	1	34 / 64	64 / 64	27,600	38,400
HEARN TGS	0	1	4 / 4	4 / 4	2,400	2,400
KEITH TGS	0	0	0 / 0	0 / 0	0	0
LAKEVIEW TGS	7	1	46 / 88	88 / 88	37,680	52,800
LAMBTON TGS	4	3	36 / 60	60 / 60	27,360	36,000
LENNOX TGS	3	3	30 / 48	48 / 48	22,320	28,800
NANTICOKE TGS	5	1	34 / 64	64 / 64	27,600	38,400
THUNDERBAY TGS	4	1	28 / 52	52 / 52	22,560	31,200
SUBTOTAL FOR FOSSIL FUEL:					167,520	228,000
AGUASABON GS			0 / 0	0 / 0	0	0
ARNPRIOR GS			0 / 0	0 / 0	0	0
DECEW NF 23 GS			0 / 0	0 / 0	0	0
PINE PORTAGE GS			0 / 0	0 / 0	0	0
SILVER FALLS GS			0 / 0	0 / 0	0	0
SIR ADAM BECK 2 GS			0 / 0	0 / 0	0	0
SUBTOTAL FOR HYDRAULIC:					0	0
TOTAL FOR ONTARIO HYDRO:					334,320	448,800
AECL						
CHALK RIVER NUCLEAR LABORATORIES	3	1	22 / 40	40 / 40	17,520	24,000
TOTAL FOR ELECTRIC POWER SECTOR:					351,840	472,800

* PROC refers to Process effluent streams, and CW refers to Cooling Water effluent streams.

** Minimum Cost would result if six trout tests and either twelve daphnia tests for process or four for cooling effluent are carried out during the year for each stream.

*** Maximum Cost would result if twelve trout tests and twelve daphnia tests tests are carried out during the year for each test stream.

SOURCE: MOE, Water Resources Branch, EPG Sector Monitoring Regulation, June 1989.

Figure 2.3 below shows that Hydro's share of the toxicity cost, assuming the maximum testing schedule, is $448,800.

Nuclear stations record the highest toxicity test cost and no testing is required for hydraulic stations. On the other hand, AECL will only incur $24,000 or 5.1% of the sector cost for toxicity testing.

Figure 2.3

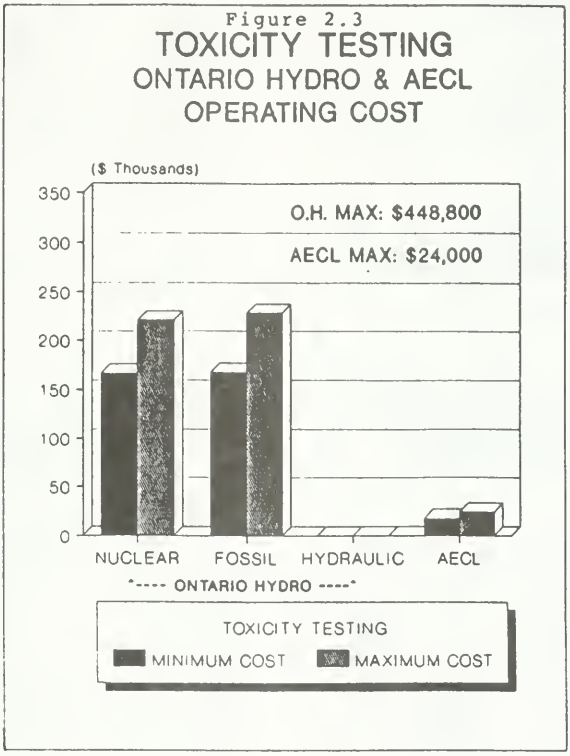
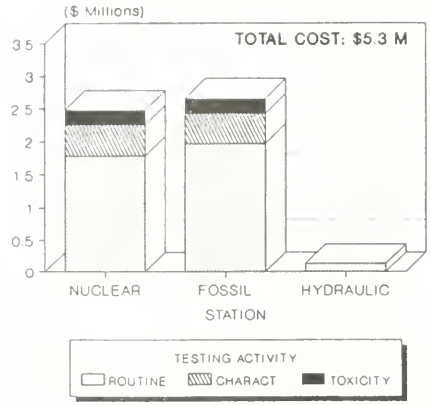


Figure 2.4 displays four graphs which show analytical and toxicity testing operating cost breakdowns for Ontario Hydro. Graph 2.4a shows component testing costs for each electric power generation source. Graphs 2.4b, c and d show these costs by individual stations for each electric power source category.

Figure 2.4

2.4a

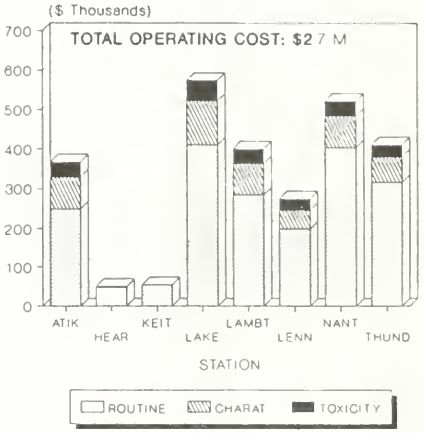
ANALYTICAL & TOXICITY
ONTARIO HYDRO
OPERATING COST



NOTE. TOXICITY TESTING ASSUMED AT MAXIMUM COST

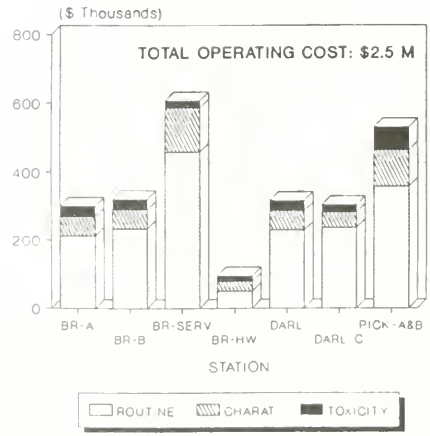
2.4b

ANALYTICAL & TOXICITY
FOSSIL-FUELLED STATIONS
ONTARIO HYDRO



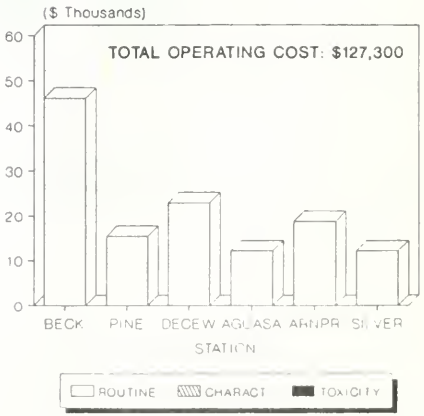
2.4c

ANALYTICAL & TOXICITY
NUCLEAR STATIONS
ONTARIO HYDRO



2.4d

ANALYTICAL & TOXICITY
HYDRAULIC STATIONS
ONTARIO HYDRO



NOTE CHARACTERIZATION AND TOXICITY COSTS ARE ZERO

2.6 Reporting and Supervision

Monitoring data will have to be assembled, recorded, stored, and reported to company management and to the Ministry of the Environment.

In addition, both Ontario Hydro and AECL cite the need and coordination of various monitoring activities and have estimated the relevant employee time and associated wage costs.

Data storage and manipulation will require several AT personal computers together with compatible peripherals and software at all nuclear and fossil-fulled stations, plus personnel dedicated to perform report generation functions. Data from hydraulic power stations will be stored in Hydro's existing mainframe computer at their head office.

Table 2.9 shows reporting and supervisory costs by station and associated facility. Capital and operating cost estimates, for reporting, as supplied by Hydro and AECL representatives, vary from about $10,800 up to $24,100 per plant. Capital costs associated with reporting are for the purchase of computers. The range of costs per plant appear to be due to the availability of existing equipment and facilities. Hydro reported that about 235 person-days of supervisory time will be required to implement the monitoring regulation at each station or facility. Using an hourly wage rate of $36 (as supplied by Ontario Hydro), the approximate cost per station or facility will range from $7,200 to $8,500.

Reporting and supervisory cost estimates for Ontario Hydro are displayed in Figure 2.5. Graph 2.5a shows that fossil-fuelled stations will incur about 40% of Hydro's total cost for the reporting and supervision. The breakdown of capital, operating and supervision costs by electric power source are displayed in the remaining graphs.

2.7 Analytical Testing of Intake Water

Another potential sampling point is intake water. The General and the Electric Power Generation Monitoring Regulations do not require monitoring of intake water but stations and associated facilities which obtain their process water from large lakes and rivers, which in turn receive wastewater discharges from other municipalities and industrial

TABLE 2.9

REPORTING AND SUPERVISION COSTS

STATION CATEGORY	STATION\FACILITY	REPORTING CAPITAL ($)	REPORTING OPERATING ($)	SUPERVISION ($)	TOTAL ($)
ONTARIO HYDRO					
FOSSIL-FUELLED:	ATIKOKAN	9,688	12,946	8,498	31,132
	THUNDER BAY	9,688	12,771	8,498	30,957
	LAKEVIEW	9,688	12,530	8,498	30,716
	LAMBTON	9,688	12,878	8,498	31,064
	NANTICOKE	9,688	12,756	8,498	30,942
	LENNOX	9,688	13,046	8,498	31,232
	KEITH	688	10,592	8,498	19,778
	HEARN	688	10,128	8,498	19,314
	SUBTOTAL:	59,504	97,647	67,984	225,135
NUCLEAR:	DARLINTON CONST.	0	13,646	8,498	22,144
	DARLINGTON	9,917	13,646	8,498	32,061
	BRUCE A	9,917	14,207	8,498	32,622
	BRUCE B	9,917	14,207	8,498	32,622
	BRUCE HWP	9,917	14,207	8,498	32,622
	BRUCE SERVICES	9,917	14,207	8,498	32,622
	PICKERING A & B	9,917	13,675	8,498	32,090
	SUBTOTAL:	59,502	97,795	59,486	216,783
HYDRAULIC:	AGUASABON	1,833	11,422	7,206	20,461
	ARNPRIOR	1,833	11,422	7,206	20,461
	S A BECK II	1,833	11,422	7,206	20,461
	DECEW II	1,833	11,422	7,206	20,461
	PINE PORTAGE	1,833	11,480	7,206	20,519
	SILVER FALLS	1,833	11,480	7,206	20,519
	SUBTOTAL:	10,998	68,648	43,236	122,882
	HYDRO TOTAL:	130,004	264,090	170,706	564,800
AECL					
NUCLEAR:	DOUGLAS POINT	0	15,000	10,000	25,000
	NPD WMF	0	10,000	5,000	15,000
	CHALK RIVER LABS	60,000	40,000	15,000	115,000
	AECL TOTAL:	60,000	65,000	30,000	155,000
	SECTOR TOTAL:	190,004	329,090	200,706	719,800

NOTE: CAPITAL COSTS INCLUDE COMPUTERS WHERE REQUIRED.
OPERATING COSTS INCLUDE EQUIPMENT MAINTENANCE AND PERSONNEL COSTS.

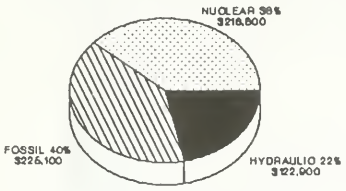
SOURCE: J.REEVES, COORDINATOR OF DATA AND INFORMATION REPORTING, ONTARIO HYDRO, 1989.
J. VAN BERLO, COORDINATOR OF DATA AND INFORMATION REPORTING, AECL, 1989.

Figure 2.5

2.5a

REPORTING AND SUPERVISION CAPITAL & OPERATING COST ONTARIO HYDRO

BY ELECTRIC POWER SOURCE

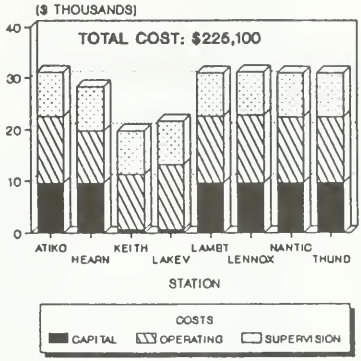


TOTAL COST: $564,800

SOURCE: ONTARIO HYDRO COST ESTIMATES, MAY 1980.

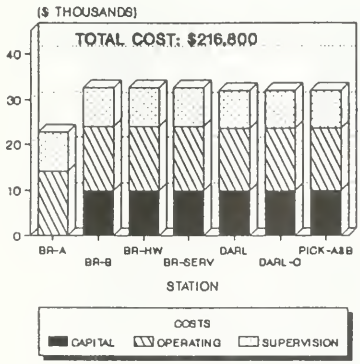
2.5b

REPORTING AND SUPERVISION FOSSIL-FUELLED STATIONS ONTARIO HYDRO



2.5c

REPORTING & SUPERVISION NUCLEAR STATIONS ONTARIO HYDRO



2.5d

REPORTING & SUPERVISION HYDRAULIC STATIONS ONTARIO HYDRO

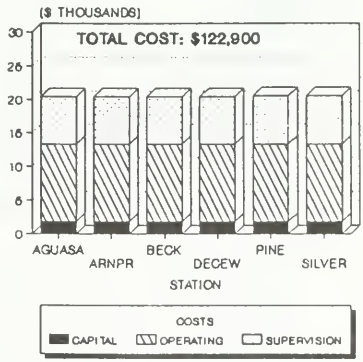


TABLE 2.10

SUMMARY OF ANALYTICAL TESTING
COSTS OF INTAKE WATER

STATION CATEGORY	STATION\FACILITY	ANNUAL COST ($)
ONTARIO HYDRO		
FOSSIL-FUELLED:	ATIKOKAN	19,400
	THUNDER BAY	25,400
	LAKEVIEW	21,400
	LAMBTON	19,400
	NANTICOKE	19,400
	LENNOX	19,400
	KEITH & HEARN	7,500
	SUBTOTAL:	131,900
NUCLEAR:	DARLINTON CONST.	0
	DARLINGTON	20,200
	BRUCE A	27,500
	BRUCE B	24,540
	BRUCE HWP	18,480
	BRUCE SERVICES	0
	PICKERING A & B	20,400
	SUBTOTAL:	111,120
HYDRAULIC:	ALL STATIONS	38,840
	HYDRO TOTAL COST:	281,860
AECL		
NUCLEAR:	DOUGLAS POINT	5,150
	CHALK RIVER LABS	13,000
	AECL TOTAL COST:	18,150
TOTAL COST FOR SECTOR:		300,010

SOURCE: J. REEVES, ONTARIO HYDRO, MAY 1989.
J. VAN BERLO, AECL, MAY 1989.

plants, are currently sampling and testing intake water. Data on intake water quality would permit the stations to determine net loadings of contaminants actually generated by the station.

Both Ontario Hydro and AECL intend to test intake water for those chemicals that they must routinely analyze. While analyses of intake water are not explicitly required by the regulation, Hydro and AECL intend to monitor intake water at a number of their facilities. The cost of routine analyses of intake water are presented to provide a complete estimate of the expenses to be incurred by these agencies.

Table 2.10 lists estimates of the intake water monitoring costs per facility assuming such monitoring would occur once per month. Under this assumption, intake water monitoring costs would range from $0 to $27,500 per station per year and $300,000 for the electric power generation sector as a whole.

2.8 Total Estimated Costs of the MISA Electric Power Generation Sector Monitoring Requirements

Table 2.11 presents a summary of the point estimates of capital costs for each monitoring function by station or associated facility. The total capital costs of compliance for the sector are estimated to be about $6.1 million. These estimates, which were provided by Hydro and AECL representatives and have not been verified nor analyzed independently, are subject to uncertainties and contingencies. AECL has applied a factor of 15% on the total monitoring costs in order to obtain an estimate for program over-runs. Applying the same 15% uncertainty and contingency measure to indicate the range of potential costs, the total capital costs of the regulation requirements could range from $5.2 million to $7.0 million. Ontario Hydro accounts for 93% of the total estimated capital costs.

Table 2.12 presents a summary of the point estimates of operating and maintenance costs for each monitoring function by station or facility. The total operating costs of compliance for the sector are estimated to be about $8.5 million. Using an uncertainty factor of $\pm$ 15%, estimates of total operating and maintenance costs associated with the Regulation range from $7.2 million to $9.8 million for the sector.

TABLE 2.11

SUMMARY OF POINT ESTIMATES OF CAPITAL COSTS

STATION/FACILITY	SAMPLING EQUIPMENT ($)	FLOW MEASUREMENT DEVICES ($)	ANALYTICAL INSTRUMENTATION ($)	REPORTING COSTS ($)	TOTAL CAPITAL COSTS ($)
HYDRO					
ATIKOKAN	139,000	33,000	93,800	9,688	275,488
THUNDER BAY	163,000	42,000	93,800	9,688	308,488
LAKEVIEW	209,250	159,000	109,900	9,688	487,838
LAMBTON	169,200	72,000	93,800	9,688	344,688
NANTICOKE	246,050	126,000	93,800	9,688	475,538
LENNOX	156,050	39,000	77,800	9,688	282,538
KEITH	50,000	9,000	0	688	59,688
HEARN	87,000	12,000	8,200	688	107,888
SUBTOTAL:	1,219,550	492,000	571,100	59,504	2,342,154
DARLINTON CONST.	185,000	96,000	109,406	0	390,406
DARLINGTON	112,000	45,000	66,353	9,917	233,270
BRUCE A	102,000	48,000	94,471	9,917	254,388
BRUCE B	102,000	60,000	96,353	9,917	268,270
BRUCE HWP	132,000	27,000	53,753	9,917	222,670
BRUCE SERVICES	375,000	135,000	227,794	9,917	747,711
PICKERING A & B	186,000	60,000	116,088	9,917	372,005
SUBTOTAL:	1,194,000	471,000	764,218	59,502	2,488,720
AGUASABON	67,000	36,000	29,200	1,833	134,033
ARNPRIOR	67,000	42,000	29,200	1,833	140,033
S A BECK II	67,000	57,000	29,200	1,833	155,033
DECEW II	67,000	36,000	29,200	1,833	134,033
PINE PORTAGE	67,000	39,000	29,200	1,833	137,033
SILVER FALLS	67,000	36,000	29,200	1,833	134,033
SUBTOTAL:	402,000	246,000	175,200	10,998	834,198
HYDRO TOTAL:	2,815,550	1,209,000	1,510,518	130,004	5,665,072
AECL					
NDP WMF	0	0	0	0	0
DOUGLAS POINT	0	0	0	0	0
CHALK RIVER LABS	250,000	120,000	0	60,000	430,000
AECL TOTAL:	250,000	120,000	0	60,000	430,000
SECTOR TOTAL:	3,065,550	1,329,000	1,510,518	190,004	6,095,072

SOURCE: TABLES 2.3, 2.5, 2.7, 2.9

TABLE 2.12

SUMMARY OF POINT ESTIMATES OF OPERATING AND MAINTENANCE COSTS

STATION/FACILITY	SAMPLING COSTS O & M ($)	SAMPLING COSTS TRANSPORT. ($)	FLOW MEASUREMENT ($)	ANALYTICAL ($)	TOXICITY TESTING (MAX. ESTIMATE) ($)	REPORTING & SUPERVISION ($)	TOTAL O & M COSTS ($)
HYDRO							
FOSSIL:							
ATIKOKAN	138,140	9,048	4,700	329,100	38,400	21,444	540,832
THUNDER BAY	120,260	1,508	6,200	380,800	31,200	21,269	561,237
LAKEVIEW	190,420	12,000	22,100	521,700	52,800	21,028	820,048
LAMBTON	118,400	12,000	9,800	364,000	36,000	21,376	561,576
NANTICOKE	144,370	12,000	17,500	483,900	38,400	21,254	717,424
LENNOX	96,380	12,000	5,700	246,200	28,800	21,544	410,624
KEITH	16,840	1,218	1,600	53,800	0	19,090	92,548
HEARN	14,700	348	2,100	47,800	2,400	18,626	85,974
SUBTOTAL:	839,510	60,122	69,700	2,427,300	228,000	165,631	3,790,263
NUCLEAR:							
DARLINTON CONST.	99,130	12,000	12,800	282,000	21,600	22,144	449,674
DARLINGTON	120,200	12,000	6,700	285,500	31,200	22,144	477,744
BRUCE A	117,860	12,000	7,200	269,500	31,200	22,705	460,465
BRUCE B	121,000	12,000	9,200	290,100	31,200	22,705	486,205
BRUCE HWP	72,600	12,000	4,200	78,300	16,800	22,705	206,605
BRUCE SERVICES	162,740	12,000	20,100	585,800	21,600	22,705	824,945
PICKERING A & B	153,740	12,000	9,200	462,900	67,200	22,173	727,213
SUBTOTAL:	847,270	84,000	69,400	2,254,100	220,800	157,281	3,632,851
HYDRAULIC:							
AGUASABON	21,150	10,868	5,200	12,200	0	18,628	68,046
ARNPRIOR	21,150	4,176	6,200	18,800	0	18,628	68,954
S A BECK II	21,850	8,352	8,700	46,200	0	18,628	103,730
DECEW II	21,850	2,784	5,200	23,000	0	18,628	71,462
PINE PORTAGE	21,150	8,780	5,700	15,500	0	18,686	69,816
SILVER FALLS	21,150	4,604	5,200	12,200	0	18,686	61,840
SUBTOTAL:	128,300	39,564	36,200	127,900	0	111,884	443,848
HYDRO TOTAL:	1,815,080	183,686	175,300	4,809,300	448,800	434,796	7,866,962
AECL							
NDP WMF	35,000	1,000	0	22,400	0	25,000	83,400
DOUGLAS POINT	20,000	1,000	0	21,500	0	15,000	57,500
CHALK RIVER LABS	116,000	6,000	4,600	296,600	24,000	55,000	502,200
AECL TOTAL:	171,000	8,000	4,600	340,500	24,000	95,000	643,100
SECTOR TOTAL:	1,986,080	191,686	179,900	5,149,800	472,800	529,796	8,510,062

SOURCE: TABLES 2.2, 2.3, 2.5, 2.7, 2.8, 2.9.

Point estimates of the total operating and capital costs to the electric power generation sector of complying with MISA monitoring requirements are summarized in Table 2.13. Based on the 15% factor, the total cost of compliance with the Regulation could range from $12.4 million to $16.8 million. The average point estimate of total cost will range from $477,300 to $645,700 per power plant.

As noted earlier, estimates of total analytical and bio-toxicity operating costs using Hydro in-house lab prices were about $1.7 million less than the estimates derived from commercial lab prices. Using the analytical and bio-toxicity cost estimates developed by Hydro instead of analytical estimates developed from commercial lab prices, the total incremental cost of compliance with the Regulation for Hydro is likely to range from $10.0 million to $13.6 million.

Total estimated incremental capital and operating costs for Ontario Hydro and AECL are shown in Figure 2.6. For Ontario Hydro, point estimates are shown for each monitoring activity by power source. Total point estimate of the incremental monitoring costs for Ontario Hydro amount to $13.5 million. AECL costs add another $1.1 million for a sector total of $14.6 million.

These total costs do not include intake water monitoring, which was discussed in Section 2.7, or the expenses related to the development of the EPGS Regulation which are noted below. However, it is recognized that the costs of intake water monitoring and pre-regulation activities are real costs to the sector.

2.9 Pre-Regulation Consultation and Meetings

Personnel from Ontario Hydro and AECL spent time at meetings and review committees in order to participate in the development of the regulations. Approximately 14 Ontario Hydro members and three AECL staff members have been assigned to MISA related tasks.

Hydro representatives reported that Hydro staff devoted an estimated 3,439 person-days between 1986 and 1989 in preparation for the MISA monitoring program, an average of about 860 person-days per year. This includes time spent preparing for and attending meetings of the Electric Power Generation Sector Joint Technical Committee (JTC) and the

TABLE 2.13

TOTAL POINT ESTIMATES OF COSTS RELATED TO THE MONITORING REGULATION

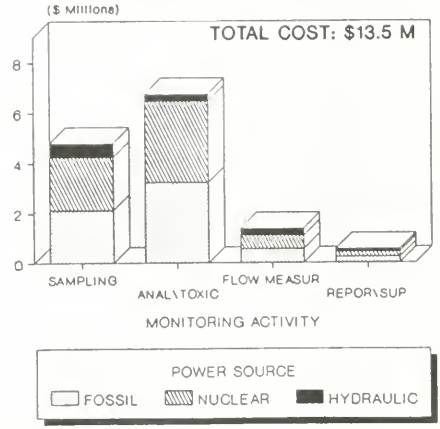
STATION/FACILITY	TOTAL CAPITAL COSTS	TOTAL OPERATING & MAINTENANCE COSTS	TOTAL COSTS (POINT ESTIMATE)
HYDRO	($)	($)	($)
FOSSIL:			
ATIKOKAN	275,488	540,832	816,320
THUNDER BAY	308,488	561,237	869,725
LAKEVIEW	487,838	820,048	1,307,886
LAMBTON	344,688	561,576	906,264
NANTICOKE	475,538	717,424	1,192,962
LENNOX	282,538	410,624	693,162
KEITH	59,688	92,548	152,236
HEARN	107,888	85,974	193,862
SUBTOTAL:	2,342,154	3,790,263	6,132,417
NUCLEAR:			
DARLINTON CONST.	390,406	449,674	840,080
DARLINGTON	233,270	482,744	716,014
BRUCE A	254,388	460,465	714,853
BRUCE B	268,270	486,205	754,475
BRUCE HWP	222,670	206,605	429,275
BRUCE SERVICES	747,711	824,945	1,572,656
PICKERING A & B	372,005	727,213	1,099,218
SUBTOTAL:	2,488,720	3,637,851	6,126,571
HYDRAULIC:			
AGUASABON	134,033	68,046	202,079
ARNPRIOR	140,033	68,954	208,987
S A BECK II	155,033	103,730	258,763
DECEW II	134,033	71,462	205,495
PINE PORTAGE	137,033	69,816	206,849
SILVER FALLS	134,033	61,840	195,873
SUBTOTAL:	834,198	443,848	1,278,046
HYDRO TOTAL:	5,665,072	7,871,962	13,537,034
AECL			
NDP WMF	0	83,400	83,400
DOUGLAS POINT	0	57,500	57,500
CHALK RIVER LABS	430,000	502,200	932,200
AECL TOTAL:	430,000	643,100	1,073,100
SECTOR TOTAL:	6,095,072	8,515,062	14,610,134

SOURCE: TABLES 2.11 AND 2.12

Figure 2.6

2.6a

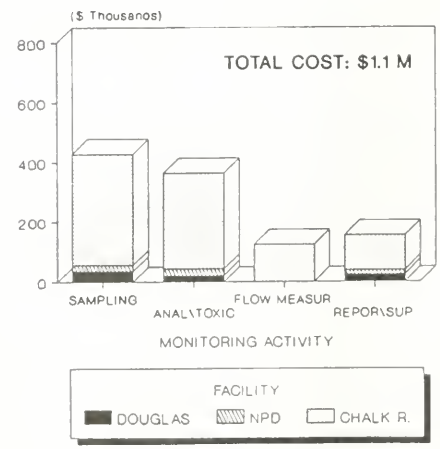
TOTAL INCREMENTAL COSTS CAPITAL AND OPERATING ONTARIO HYDRO



SOURCE ONTARIO HYDRO COST ESTIMATES, MAY 1989

2.6b

TOTAL INCREMENTAL COSTS CAPITAL AND OPERATING AECL



SOURCE AECL COST ESTIMATES, JUNE 1989

Economic, Analytical and Regulation Writing Subcommittees and carrying out various pre-regulation monitoring tasks.

AECL reported that their staff devoted only about 165 person-days to MISA-related activities during 1988 and 1989, or about 83 person-days per year.

In total, about 3,600 person-days were spent on pre-regulation assessments, consultations and meetings. Using an average wage rate of $45 per hour (as supplied by Hydro and AECL) pre-regulation expenses for the sector amount to $1.1 million.

In addition to the pre-regulation consultation and meeting costs, Ontario Hydro incurred pre-regulation chemical analyses costs. Hydro representatives reported that in 1987 and 1988 total expenses for pre-regulation chemical analyses amounted to about $800,000.

3.0 ECONOMIC IMPLICATION OF THE INCREMENTAL MONITORING COSTS

3.1 Introduction

The monitoring regulations require that funds be allocated to monitoring activities that would otherwise be used for other purposes. In other industrial sectors, the extra costs would either reduce profits (or increase losses) or, which is more likely in the long run, some or all of the extra costs would be passed on as higher product prices.

In other industrial sectors whose firms operate in more or less competitive markets, analyses were carried out to determine, under certain assumptions, what effect the extra costs would have on before and after-tax profits, capital expenditures and the rate of return on investment or capital employed. The latter measure is an indicator of the return needed to induce owners to continue operating the enterprise.

Ontario Hydro and AECL are both crown corporations. Ontario Hydro in particular does not operate in a competitive market. Like all electric utilities, Hydro is a virtual monopoly; the sole supplier of electricity in its service area, the province of Ontario. Electricity rates and Ontario Hydro's rate of return are reviewed by the Ontario Energy Board (OEB). The OEB reviews annual rate increase proposals and recommends a specific rate change which Hydro's board of directors may or may not adopt. The financial indicators and measures of effects which are important to competitive enterprises, are not, therefore, entirely relevant to a monopoly enterprise like Ontario Hydro.

3.2 Industry Performance and Outlook

The electric power generation industry is sensitive to provincial, national and international economic factors. The industry operates within a highly capital intensive infrastructure which is largely financed by long-term debt. Canadian electric utilities normally finance a portion of their capital requirement from international lenders. According to the Department of Energy, Mines and Resources Canada (1988), Ontario Hydro borrowed $10.1 billion or 43% of its long-term debt requirement from foreign lenders in the United States, western Europe and Japan during 1986.

Ontario Hydro's revenues from electricity sales have increased by an average of 11% per year between 1982 and 1987. Revenue totalled $5.3 billion in 1987. Hydro's total operating expenses, excluding financing charges, have increased by an average of 8% per year for the same period totalling $3.2 billion in 1987. Long-term debt for the Corporation has increased by 10% per year between 1982 and 1987. Ontario Hydro earned a net income (which is equivalent to after-tax profit for a private corporation) of $271 million in 1987 compared with $247 million in 1986.

Ontario Hydro's main financial indicators, as discussed in the Economic and Financial Profile of the Ontario Electric Power Generation Industry (MOE, June 1989), include debt, cash flow coverage and interest coverage ratios. The ratio of debt to debt plus "equity" for the period 1983 through 1987 has floated between 0.83 and 0.84. The interest coverage ratio, which measures the Corporation's ability to meet interest and debt repayment obligations, has been held at above 1.0 for the period 1983 to 1987. Hydro's cash flow coverage ratio has been marginally increasing each year from 1983 to 1987, reaching a high of 1.08 in 1987. Overall, Ontario Hydro financial position remains strong.

In contrast, AECL has experienced a steady decrease in total revenue over the period 1983 to 1987. In 1987, the Federal crown corporation generated $268 million in total revenue on consolidated operation which is down from a five-year high of $409 million in 1983. On the other hand, net income or profits increased from $9 million in 1984 to $17 million in 1986 but remained steady at $17 million in 1987. Investments in fixed assets and the value of AECL's total assets have generally been decreasing since 1984. AECL's financial position remains good but it is presently undergoing a restructuring of its operations.

The National Energy Board expects Canadian utilities to continue to provide reliable supplies of electricity up to the year 2005 without supply shortfalls or major price increases.

According to Energy, Mines and Resources (1988), the average annual growth rate for electricity demand in Canada for the period 1987 to 2005 is forecast to be 2.1%. Ontario's demand for electricity is also expected to rise by 2.1% for the same period.

The Ontario Ministry of Energy (1987) estimates that electricity consumption in Ontario will grow by 2.3% annually to the year 2000. Ontario Hydro forecasts electricity consumption to grow at an annual rate of 2.7% over a shorter 1988-1991 period.

These forecasts are somewhat lower than the electricity consumption increases that have been recorded over the past three decades in Ontario. Between 1960 and 1987, electricity consumption in Ontario grew by 4.8% per year although growth slowed to 3.3% between 1975 and 1987 (Energy, Mines and Resources Canada, 1988). Consumption in Ontario increased by 4.1% between 1986 and 1987.

3.3 Implications for Ontario Hydro

Because Ontario Hydro is a legal monopoly, it can raise electricity rates, subject to review by the Ontario Energy Board, to recover extra costs and maintain profits and rates of return at designated levels. In fact, extra costs incurred by Hydro for any reason are translated into "revenue requirements" reflecting the expectation of cost recovery by the utility through subsequent rate increases.

Therefore, virtually all of the extra costs of monitoring and other environmental protection activities can be passed on to electricity customers in higher rates. Given this ability, a primary public policy concern for this particular sector is whether the monitoring requirements are being implemented in the most efficient or cost-effective manner possible.

Although it has been impossible to carry out an exhaustive evaluation of the cost-effectiveness of Hydro's proposals in this review, some indicators were noted. For example, certain cost items such as the construction of roads to access sampling points at power plants and the allocation of substantial amounts of expected supervisory effort to the monitoring program were unique to Ontario Hydro among all industrial sectors subject to MISA monitoring requirements. Moreover, some equipment prices quoted in the Hydro proposals were higher than prices cited by other industrial firms for the same items.

On the other hand, costs of chemical analyses and toxicity tests that will be incurred by Hydro in its own lab facilities are expected to be significantly lower than what commercial labs would charge. Moreover, Ontario Hydro staff have prepared one of the most detailed set of estimates of any enterprise subject to a monitoring regulation. These estimates are, therefore, probably the most accurate. Finally, and most importantly, the facilities and levels of effort being proposed by Hydro to comply with the monitoring regulation are consistent with the significant, long-term improvements in environmental protection that are expected of a Crown Corporation. Ontario Hydro's plants are large, long-lived facilities which will require continued monitoring of both air- and water-borne wastes and contaminants for many years into the future.

From Ontario Hydro's point of view, two financial effects are of primary concern.

First, Hydro determines what the added costs mean in terms of a "revenue requirement". The revenue requirement is the amount of revenue that will have to be collected over the following year to cover all expected expenses plus provide for a target "net income" which is used for debt retirement and rate stabilization. More precisely, the revenue requirement for any given year is the addition of operating, maintenance and administration costs, fuel and fuel related costs, depreciation expenses, foreign exchange expenses and net income less return from export sales.

The second financial implication of concern is the extent to which Hydro would have to borrow funds to cover capital expenses rather than pay them out of current revenues. Officials from Ontario Hydro stated that the estimated capital expenses to be spent on monitoring are not large enough to have an effect on the Corporation's debt structure.

The monitoring expenses that would be used to calculate the revenue requirement consist of the estimated operating expenses plus the portion of the capital costs to be "expensed" during the year in question. Up to 100% of the capital costs could be expensed in a given year but the Corporation usually annualizes capital expenditures over a specified depreciation period at current interest rates and uses only the annualized capital cost as an expense in any given year.

Officials in the Financial Planning Department of Ontario Hydro have indicated that capital costs for monitoring could be capitalized over 5 years at an interest rate of about 10%.

Therefore, the total expenses to be used in calculating the revenue requirement during the 12-month period of the monitoring regulation include total operating costs of $7.9 million plus $1.5 million, which is the average annualized value of the estimated $5.7 million in capital costs, at 10% over 5 years, for a total of $9.4 million. The remaining capital costs would be expensed at about $1.5 million per year over the next 4 years. The actual annualized value would decline over time, but would average about $1.5 million.

According to personnel in the Financial Planning Department, a $9.4 million revenue requirement would amount to a rate increase of about 0.15% in 1990 if all of these costs were passed on to customers. Hydro could choose to expense all expected capital and operating costs for monitoring in one year, in which case the revenue requirement would amount to $13.5 million and the potential rate increase would be closer to 0.2% for 1990.

These costs are small in comparison to the $5.3 billion in total revenues earned by Ontario Hydro in 1987 and the $2.5 billion in capital expenditures incurred during that same year.

It appears that the monitoring costs will have a minimal effect on future annual rate increases. However, it should be noted that, in addition to the impact of the proposed monitoring costs, other environmental protection costs will have to be incurred by Hydro such as the acid gas control program known as "Countdown Acid Rain". Ontario Hydro (1987) has estimated that $7.7 million would be spent for consulting and preliminary assessments of technologies for acid gas control. The latest program plan estimates indicate that Hydro proposes to spend $2.46 billion between 1989 and 2000 on the reduction of acid gas emissions.

As water discharge, air emission and solid waste management requirements become more stringent, Ontario Hydro and other industrial sectors will face additional monitoring and abatement costs. The cost-effectiveness as well as the impacts and implications of these costs in their entirety will have to be analyzed.

The MISA monitoring program may create a number of new job positions at Hydro. It has been estimated that about 38 additional person-years will be required to implement the regulation requirements. Hydro has indicated that much of the monitoring work will be carried out by existing staff so that, during the 12-month monitoring period, the number of new employees that will actually be hired is unknown.

3.4 Implications for AECL

AECL is also a crown corporation, but it is in the process of being "privatized". Some components of the corporation are being sold to private interests while others are being urged to generate sales and revenues sufficient to turn a profit.

Total monitoring expenses for AECL are estimated to range from $0.9 million to $1.3 million. Estimated capital costs of the monitoring requirements are likely to range from $0.4 million to $0.5 million or about 39% of total monitoring expenses for AECL.

In 1987, AECL generated sales of $277 million with after-tax profits of $17 million. Capital expenditures in the same year were $28 million with long-term debt of $623 million.

Against AECL's profitability and capital budget, monitoring costs appear to be rather modest. Borrowing additional funds to cover $430,000 in capital expenses for monitoring would increase total debt by only a fraction of 1%. Operating costs of $1.3 million amount to only 8% of AECL's after-tax profit for 1987.

In terms of employment, AECL reports that the MISA monitoring program would require approximately 5 person-years of effort over the 12-month monitoring period to satisfy the regulation requirements. However, AECL representatives have indicated that most of the monitoring tasks will be completed by existing staff.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The point estimate of the total incremental costs for the sector to comply with the regulation is $14.6 million, ranging from $12.4 million to $16.8 million. The range cited is due to uncertainties associated with both capital and operating cost estimates and to possible program cost over-runs. The average point estimate of total costs per station or associated facility ranges from $477,300 to $645,700.

Estimated capital costs are expected to range from $5.2 million to $7.0 million for Ontario Hydro and AECL with a point estimate of $6.1 million. Hydro accounts for over 93% of the total estimated capital costs. The average point estimate of capital costs per station or associated facility is $234,600.

The point estimate of total operating and maintenance costs for the sector amounts to $8.5 million ranging from $7.2 million to $9.8 million. The point estimate of operating costs averages $236,900 per station or associated facility.

Based on analyses of the impacts of incremental monitoring costs on Hydro's revenue and debt requirements and on AECL's profitably and capital budget, the MISA monitoring requirements are not expected to have any adverse financial effects on the two Crown Corporations. The extra costs could precipitate electricity rate increases by a maximum of 0.2% in 1990. The costs to AECL are not expected to adversely affect the corporation's operating profit.

However, in addition to the MISA monitoring costs, other present and future environmental protection costs (e.g. Hydro's acid gas reduction program) will have to be incurred and will have financial implications for firms, Crown Corporations and government agencies.

4.2 Recommendations

At the end of the regulation period, it is recommended that each plant or facility report the actual incremental expenses that were incurred due to the MISA monitoring requirements in order to:

- validate and improve the cost-estimation procedures used in this report.

- monitor and assess the financial and employment impacts of the monitoring requirements.

The cumulative financial burdens of monitoring requirements in other sectors, other MISA requirements, air and solid waste control regulations and regulatory requirements by other federal and provincial agencies should be monitored.

Finally, when monitoring data and activities at these plants (and other industrial dischargers) are audited by MOE personnel or their agents, information should be gathered to determine whether the monitoring activities or data have been, or could be, helpful in making the operations or processes more efficient and productive.

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